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MORALITY BEFORE KNOWLEDGE

The role of mobile commerce service quality in enhancing consumer loyalty: A strategic business perspective

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ABSTRACT

Background: The development of e-commerce in Indonesia shows significant growth, with the number of users predicted to continue to increase until 2029. This phenomenon is driven by easier internet access and the widespread use of smartphones. This study aims to analyze the effect of mobile commerce aplication (MCA) service quality on consumer loyalty intentions in Shopee e-commerce through consumer satisfaction. **Methods:** This research uses a quantitative method with a causal approach. Data was collected through a Google Form questionnaire distributed to 238 respondents with a sampling process using non-probability techniques with samples selected purposively. The SERVQUAL model, is adopted to evaluate MCA service quality and its influence on customer satisfaction and loyalty intention. The statistical method of partial least squares structural equation modeling (PLS-SEM) analyzed with SmartPLS 4 software and then evaluated through combined importance performance map analysis (cIPMA). **Findings:** The results of this study show that customer satisfaction has a positive and significant effect on customer loyalty intention. Service quality has a positive and significant effect on customer loyalty intention through customer satisfaction, including variables of information quality, personalization, reliability, and usability while assurance, responsiveness, and security do not have a positive and significant effect. **Conclusion:** The study concludes that customer satisfaction plays a crucial role in strengthening customer loyalty intention in Shopee's mobile commerce. Among the examined service quality dimensions, information quality, personalization, reliability, and usability significantly enhance loyalty through satisfaction, while assurance, responsiveness, and security show no significant impact. **Novelty/Originality of this article:** This study offers novelty by identifying which specific dimensions of Mobile Commerce Application (MCA) service quality directly strengthen customer loyalty intention through satisfaction in the context of Shopee—revealing that only information quality, personalization, reliability, and usability have significant effects, while assurance, responsiveness, and security do not.

KEYWORDS: business strategy; customer loyalty intention; customer satisfaction; e-commerce strategy; service quality.

1. Introduction

In a report entitled 'Internet economy size in Southeast Asia in 2024, by country' published by Statista Research Department (2025), it is stated that the internet economy in Southeast Asia (SEA) is poised for significant growth, with Indonesia leading the way. Indonesia, as the country with the largest population in SEA, is certain to have the largest e-commerce market in the region. In 2024, Indonesia's e-commerce GMV will reach around US$65 billion and is expected to reach USD150 billion by 2030, driven by the rapidly growing e-commerce user base in Indonesia. On the other hand, Thailand, Vietnam, and the

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Philippines have comparable e-commerce market sizes, while Malaysia and Singapore have smaller market sizes than these countries. The e-commerce market in Southeast Asia is expected to continue to grow in the coming years; however, the Statista Research Department believes that Indonesia, Thailand, Vietnam, and the Philippines are expected to grow at a much faster rate than Malaysia and Singapore.

In this competitive landscape, Shopee became the platform with the highest number of visitors in Indonesia throughout 2023, rising by 41.39% year-to-date, while competitors such as Tokopedia, Lazada, and Bukalapak experienced significant declines (Ahdiat, 2024). Based on the latest survey in 2025 by the Indonesian Internet Service Providers Association (APJII Survey Team, 2025), Shopee ranks first as the most frequently accessed e-commerce platform by Indonesians, with 53.22% of respondents choosing it. In second place, TikTok Shopee garnered 27.37% of users. Tokopedia ranked third with 9.57% and other e-commerce platforms (0.21%) were at the bottom of the list. Despite being the market leader, Shopee still faces challenges in maintaining service quality due to changing consumer preferences and competitive dynamics (Fadhilah et al., 2023; Farida & Setiawan, 2022).

Shopee is a leading e-commerce platform in Taiwan and Southeast Asia, founded by SEA Group owned by Forrest Li and launched in 2015 by Chris Feng from Singapore. With millions of users, Shopee has grown rapidly and become one of the most popular online shopping platforms in Indonesia thanks to its user-friendly application, wide selection of products and sellers, competitive prices, and strong service quality. Shopee has also received various awards, including "Best E-Commerce" at the 2021 Selular Awards (Redaksi Selular.ID, 2021), and has been downloaded more than 100 million times with 14 million reviews and a 4.6/5 rating on Google Play. The platform is known for its intuitive interface, simple navigation, and secure and fast shopping experience supported by reliable payment and logistics systems (Aunillah & Himawan, 2022).

Technological developments in the era of globalization have transformed various aspects of business through innovations that integrate global connectivity and expand market opportunities, including increasingly rapid and efficient cross-regional communication (Ayu et al., 2022). The high internet penetration rate in Indonesia—reaching 73.7% of the population or 196.71 million users, with Java accounting for 56.4%—shows a significant increase compared to 2018 (Dewa, 2022), thereby driving the emergence of e-commerce as a business model capable of increasing market demand and reducing operational costs (Zeng et al., 2017; Utami & Wiyono, 2023). The trend shows a change every year, with more people switching to m-commerce than web-commerce, along with the impact of COVID-19 on online retail consumer purchasing behaviour (Afonso et al., 2024). Various reviews on Google Play Store and the App Store highlight complaints related to slow app performance, auto-playing videos that consume mobile data, the removal of the product zoom feature, additional service fees even when using ShopeePay or PayLater, unprofessional SPX courier services, unresponsive customer service, and unfiltered vulgar content, reflecting technical and operational issues that affect customer satisfaction and loyalty.

The Shopee application rating on the Google Play Store and App Store stands at 4.7 out of 5, indicating that the majority of users positively evaluate the app's quality, ease of use, and available features. Nevertheless, Shopee still needs to address the concerns of the small portion of users who provide low ratings to ensure continuous improvement in the responsiveness and quality of its mobile commerce services (Zariman et al., 2022). As one of the leading e-commerce market players in Indonesia, studies on Shopee's service quality remain limited, making this research highly relevant. Service quality must be examined in greater depth so that Shopee can maintain its competitive advantage and serve as a benchmark for other platforms amid increasingly intense digital competition. This study employs the grand theory of Heizer (2020) on the ten strategic decisions in operations management, focusing specifically on quality management. The SERVQUAL model (Parasuraman et al., 1988), modified by Zariman et al. (2022), is adopted to evaluate MCA service quality and its influence on customer satisfaction and loyalty intention. The

SERVQUAL model, developed by Parasuraman et al. (1988), is a widely recognised framework for measuring service quality across various industries. This model consists of five dimensions: physical aspects, reliability, responsiveness, assurance, and empathy. However, this model cannot be applied universally in its original form and often requires adjustments to suit the context of a particular industry (Naylor, 2024).

This research refers to the study by Zariman et al. (2022), which identified seven key indicators of MCA service quality: assurance, information quality, personalization, reliability, responsiveness, security, and usability. This study differs by focusing on a single object—Shopee—within the Indonesian geographic context, and by employing the IPMA approach (Hauff et al., 2024) to identify service indicators that are important but underperforming. This approach offers both theoretical and practical contributions by linking quality management theory with digital consumer behavior, while also opening opportunities for future research on developing service quality models in line with evolving customer preferences and digitalization.

In measuring customer loyalty, SERVQUAL is used to evaluate the extent to which services meet or exceed customer expectations. Since e-services differ from traditional services—characterized by virtual interaction, minimal physical elements, and self-service—the dimensions of empathy and tangibles are excluded from this study (Parasuraman et al., 1988; Carlson & O'Cass, 2011; Zariman et al., 2022). Instead, additional variables such as personalization, information quality, security, and usability are included, as they are more relevant in mobile-based service contexts (Zariman et al., 2022). This study uses customer loyalty (Y) as the dependent variable, service quality (X) as the independent variable, and customer satisfaction (Z) as the intervening variable. The analyzed service quality dimensions include assurance, information quality, reliability, responsiveness, security, and usability. This research model is considered more effective in supporting managerial actions aimed at improving key target constructs (Sarstedt et al., 2024). The research problem is further supported by findings from Zariman et al. (2022), which demonstrate a direct relationship between MCA service quality, customer satisfaction, and customer loyalty intention.

2. Methods

2.1 Research design and variable

The research strategy employs a survey to generalize findings from the sample to a broader population and to understand relationships between variables (Creswell & Creswell, 2018). The study uses a cross-sectional design, meaning that data are collected at one point in time without repetition (Sekaran & Bougie, 2016). The purpose of this research is to test theory through hypothesis formulation and the collection of data that support or refute those hypotheses, specifically to determine the effect of Shopee's mobile commerce application service quality on customer satisfaction and customer loyalty intention.

The research variables consist of the independent variable—MCA service quality, which includes assurance, information quality, personalization, reliability, responsiveness, security, and usability; the dependent variables—customer satisfaction and customer loyalty intention; and the intervening variable, which serves as a mediator between the independent and dependent variables (Creswell & Creswell, 2018; Sekaran & Bougie, 2016). The study uses an ordinal measurement scale with a five-point Likert scale to assess respondents' perceptions and opinions, as this scale effectively differentiates levels of agreement in measurable ways (Cooper & Schindler, 2014; Sekaran & Bougie, 2016; Indrawati, 2015).

The use of PLS-SEM is growing in operations management. Practical guidelines have been developed to help researchers apply the technique correctly and effectively (Peng & Lai, 2012) PLS-SEM was selected in this study as a tool for evaluating the proposed theoretical model. PLS-SEM is well suited for studies that focus on prediction and involve complex model structures with many variables and relationships (Bianchi & Saleh, 2024;

Guenther et al., 2023). PLS-SEM is often preferred over CB-SEM due to its flexibility, fewer statistical assumptions, ability to handle complex models, and strong predictive power. However, the choice between PLS-SEM and CB-SEM ultimately depends on the specific research context and objectives (Vukovi´c, 2024). Hair & Alamer, (2022) have provided guidelines for evaluating measurement models using three main criteria: reliability, convergent validity, and discriminant validity. Reliability is evaluated using Cronbach's alpha and composite reliability, with all values exceeding 0.7 indicating strong internal consistency. Convergent validity is evaluated based on factor loadings, which should generally exceed 0.7. However, items with loadings below 0.7 are still considered acceptable if the related construct achieves an average extracted variance (AVE) of more than 0.5 (Koay & Low, 2025).

The research stages include problem formulation to identify the phenomena that need investigation (Creswell & Creswell, 2018); development of a theoretical foundation to build a conceptual framework (Sekaran & Bougie, 2016; Sugiyono, 2019); hypothesis formulation based on the adopted theories; data collection using Google Forms distributed via social media; data analysis using SPSS 25 for validity and reliability tests and Smart PLS 4 with the cIPMA approach; and drawing conclusions and providing recommendations based on the findings (Sugiyono, 2019; Habsy et al., 2024).

The research population includes all users of Shopee's mobile commerce application in Indonesia (Sekaran & Bougie, 2016). The sample was selected using non-probability purposive sampling, which involves choosing respondents believed to be capable of providing relevant information (Indrawati, 2015; Sugiyono, 2019). The Non-Probability Purposive Sampling method was chosen because it is effective for studying specific cultural domains or populations that are difficult to survey by selecting knowledgeable informants (Gevaert et al., 2025). which also have significant percentages. The sample size was determined using G-Power software with a multiple regression F-test, which allows researchers to assess the extent to which predictor variables have a significant influence on the dependent variables, enabling stronger conclusions regarding relationships among variables.

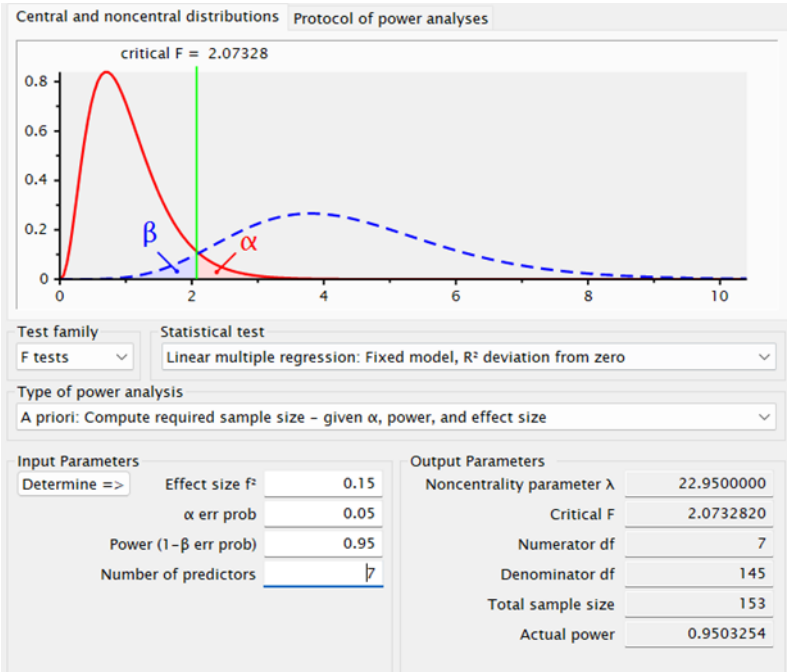

Fig. 1. Graph of calculations using G-Power version 3.19

The sample size calculation using G-Power version 3.1 on Figure 1 shows that this study requires 153 respondents. This number was calculated through an F-test with an effect size of 0.15 to detect relationships between variables with the smallest effect (Hanif,

2020). With a significance level of 0.05, a power of 0.95, and seven predictor variables, the G-Power software version 3.1.9 generated a total sample size of 153 respondents. The respondent criteria include active users of the Shopee mobile commerce application, individuals who have made at least three transactions, and those who are willing to participate in the study.

2.2 Data collection and research instrument

For data collection, this study uses two types of data sources. Primary data were obtained directly from respondents through the distribution of questionnaires, which were chosen because they provide researchers full control over the data collection process (Sekaran & Bougie, 2016). Questionnaires are considered effective for obtaining relevant information as long as the researcher understands the variables being measured (Sugiyono, 2019). In addition, this study also utilizes secondary data derived from literature sources such as books, scientific journals, websites, and other relevant scholarly works. These secondary data are used to strengthen the theoretical foundation through a literature review (Sekaran & Bougie, 2016).

The research instruments used in this study consist of a questionnaire and a literature analysis. The questionnaire was developed in the form of written questions or statements covering nine variables to measure the dimensions of mobile commerce application service quality in relation to customer satisfaction and customer loyalty intention. The questionnaire blueprint includes statements representing seven service quality dimensions: assurance, information quality, personalization, reliability, responsiveness, security, and usability. The questionnaire was then distributed to respondents who are users of the Shopee mobile commerce application.

2.3 Validity and reliability testing

In addition to establishing the research instruments in the form of a questionnaire and a literature analysis, the next step is to ensure that these instruments are truly suitable for use. According to Sugiyono (2019), validity testing is conducted by comparing the data obtained by the researcher with the intended data, allowing an assessment of whether the instrument genuinely measures what it is supposed to measure. Each statement in the questionnaire must be able to represent the construct being examined in order to be considered valid. In this study, the validity test was applied to assess the accuracy of the questionnaire items covering various dimensions of mobile commerce service quality. The testing was carried out using SPSS software version 25.0 or through manual calculations using the Pearson Product Moment correlation technique.

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{[N\sum X^2 - (\sum X)^2][N\sum Y^2 - (\sum Y)^2]}} \quad \text{(Eq. 1)}$$

r_{xy} represents the correlation coefficient, n denotes the sample size, x refers to the score for each questionnaire item, and y indicates the total score. A questionnaire is considered valid if the calculated correlation coefficient (r) is greater than or equal to the r value listed in the table. According to Ghozali (2018), for n = 31 and a significance level of 5% (0.05), the table r value is 0.355. In this study, the validity of the questionnaire was evaluated using SPSS software version 25 to ensure simple and error-free data processing. The results of the validity test can be found in Table 1, which presents the data analysis conducted using SPSS 25. Based on the results in Table 1, it can be concluded that each question in this study's questionnaire can be considered valid, as the calculated r values are greater than the table r values.

Table 1. Validity test

Variable	Code	R Table	R Calculated	Description
Assurance	AS.1	0.355	0.928	Valid
	AS.2	0.355	0.912	Valid
	AS.3	0.355	0.810	Valid
	AS.4	0.355	0.638	Valid
	AS.5	0.355	0.790	Valid
Information Quality	IQ.1	0.355	0.934	Valid
	IQ.2	0.355	0.930	Valid
	IQ.3	0.355	0.882	Valid
	IQ.4	0.355	0.941	Valid
	IQ.5	0.355	0.930	Valid
	IQ.6	0.355	0.711	Valid
	IQ.7	0.355	0.849	Valid
Personalization	PS.1	0.355	0.926	Valid
	PS.2	0.355	0.941	Valid
	PS.3	0.355	0.912	Valid
Reability	RL.1	0.355	0.647	Valid
	RL.2	0.355	0.895	Valid
	RL.3	0.355	0.799	Valid
	RL.4	0.355	0.865	Valid
	RL.5	0.355	0.841	Valid
	RL.6	0.355	0.861	Valid
	RL.7	0.355	0.658	Valid
Responsiveness	RS.1	0.355	0.768	Valid
	RS.2	0.355	0.832	Valid
	RS.3	0.355	0.910	Valid
	RS.4	0.355	0.852	Valid
	RS.5	0.355	0.871	Valid
	RS.6	0.355	0.738	Valid
	RS.7	0.355	0.838	Valid
Security	SC.1	0.355	0.886	Valid
	SC.2	0.355	0.922	Valid
	SC.3	0.355	0.931	Valid
	SC.4	0.355	0.837	Valid
Usability	US.1	0.355	0.802	Valid
	US.2	0.355	0.837	Valid
	US.3	0.355	0.808	Valid
	US.4	0.355	0.769	Valid
	US.5	0.355	0.892	Valid
	US.6	0.355	0.851	Valid
Customer Satisfaction	CS.1	0.355	0.928	Valid
	CS.2	0.355	0.931	Valid
	CS.3	0.355	0.920	Valid
	CS.4	0.355	0.910	Valid
	CS.5	0.355	0.893	Valid
Customer Loyalty	CL.1	0.355	0.818	Valid
Intention	CL.2	0.355	0.934	Valid
	CL.3	0.355	0.977	Valid
	CL.4	0.355	0.971	Valid
	CL.5	0.355	0.956	Valid

Next, after the validity of the instruments was confirmed, the study also conducted a reliability test to assess the consistency and accuracy of the measurement tools used. According to Sugiyono (2019), reliability testing aims to ensure that the instruments produce consistent and dependable measurements. Reliability analysis is carried out by evaluating the suitability and consistency of the items in the questionnaire. In this study, the reliability test was conducted using SPSS software version 25 or through manual

calculations using the Cronbach's Alpha formula, ensuring that each item in the questionnaire is reliable and suitable for data collection.

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\Sigma\sigma_t^2}{\sigma_t^2}\right) \quad \text{(Eq. 2)}$$

r_{11} represents the reliability coefficient being calculated, *n* denotes the number of items tested, $\Sigma\sigma_i^2$ refers to the sum of the variance of each item score, and σ_t^2 indicates the total variance. This study utilized SPSS version 25 to facilitate the reliability test calculations and minimize potential errors. According to Ghozali (2018), a research instrument is considered reliable if its Cronbach's Alpha value is greater than 0.60. Based on this criterion, questionnaire items are categorized as reliable if the Cronbach's Alpha value > 0.60, whereas items with a Cronbach's Alpha value < 0.60 are considered unreliable. The results of the reliability test in this study, conducted using SPSS version 25, are presented in Table

Table 2. Reliability test

No	Variable	Alpha	Description
1	Assurance	0.876	Reliable
2	Information quality	0.953	Reliable
3	Personalization	0.917	Reliable
4	Reability	0.899	Reliable
5	Responsiveness	0.923	Reliable
6	Security	0.913	Reliable
7	Usability	0.898	Reliable
8	Customer satisfaction	0.952	Reliable
9	Customer loyalty intention	0.962	Reliable

In this study, hypothesis testing was conducted using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach through SmartPLS software, which allows for the analysis of complex relationships between latent variables and their indicators (Martínez et al., 2023; Santoso & Indrajaya, 2023). Hypotheses were tested based on t-statistic values to determine acceptance or rejection, with a one-tailed test applied because the hypotheses had a clearly defined direction according to quality management theory and the modified SERVQUAL model (Heizer, 2020; Zariman et al., 2022). Testing was performed on the measurement model (outer model) to ensure the validity and reliability of indicators, using criteria such as loading factor > 0.60, composite reliability > 0.70, AVE > 0.50, and discriminant validity (Ghozali, 2018; Maria & Birawan, 2022). Meanwhile, the structural model (inner model) was used to predict causal relationships between latent variables with R^2, effect size f^2, Q^2, and goodness-of-fit parameters such as AVIF, AFVIF, and RSCR (Ghozali, 2018).

In addition, this study examines the mediating effect, namely the influence of independent variables on dependent variables through mediating variables, using the SEM-PLS method for efficiency in complex models. A t-statistic significance value ≥ 1.96 indicates full mediation (Abdillah & Hartono, 2015; Maria & Birawan, 2022). The hypotheses tested for reliability in Table 2 include the effect of mobile commerce service quality dimensions (guarantee, information quality, personalisation, reliability, responsiveness, security, and ease of use) on customer satisfaction, as well as the effect of customer satisfaction on loyalty, including the mediating role of customer satisfaction in these relationships.

Combined Importance–Performance Map Analysis (cIPMA) is an analysis method that combines the results of Importance–Performance Map Analysis (IPMA) and Necessary Condition Analysis (NCA) in Partial Least Squares Structural Equation Modeling (PLS-SEM). cIPMA enables the prioritization of management actions to better improve the construction of key targets (Sarstedt et al., 2024). cIPMA introduces conceptual models and theoretical arguments as well as relevant hypotheses in their demonstration of the combined use of

PLS-SEM and NCA (Hauff et al., 2024). The main difference between cIPMA and previous versions of IPMA is that cIPMA integrates the analysis of necessary conditions (NCA) into its performance map. While traditional IPMA only considers the total influence of various constructs on the target construct, cIPMA also highlights the conditions that must be present for certain results to be achieved. This enables cIPMA to provide more comprehensive guidance and better prioritization in managerial actions, as it not only shows the importance and performance of constructs, but also whether those constructs are necessary conditions for achieving the desired results (Sarstedt et al., 2024).

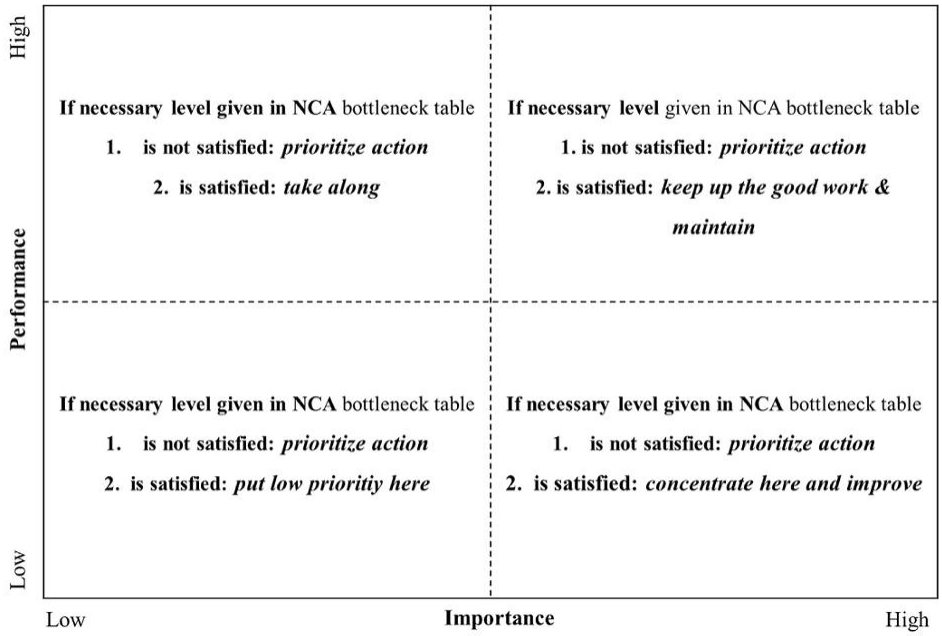

Fig. 2. Managerial recommendations based on the combined IPMA (cIPMA) (Hauff et al., 2024)

Within the framework of Combined Importance Performance Map Analysis (cIPMA) on Figure 2, managerial recommendations are determined by combining two analytical approaches, namely sufficiency logic derived from Partial Least Squares Structural Equation Modelling (PLS-SEM) and necessity logic derived from Necessary Condition Analysis (NCA). The explanation of the four quadrants in cIPMA and their managerial implications, as outlined by Hauff et al. (2024), highlights how importance and performance jointly inform strategic decision-making. The first quadrant, High Importance and High Performance, includes key factors that are both critical and already performing well. When the requirements are satisfied, the appropriate managerial action is to maintain existing practices by "keeping up the good work," ensuring consistency and sustainability. However, if the requirements are not satisfied, the recommendation shifts to prioritizing action, as these factors—despite strong performance—have not yet reached the minimum threshold and may become constraints in achieving optimal outcomes.

The second quadrant, High Importance and Low Performance, represents the most critical area in cIPMA. Factors in this category are essential but underperforming. If the requirements are satisfied, management should "concentrate here and improve," directing resources toward enhancing performance due to their significant impact on results. If the requirements are not satisfied, the urgency increases, and "prioritize action" becomes necessary, as these factors both fail to meet minimum standards and directly hinder target achievement.

The third quadrant, Low Importance and Low Performance, consists of factors with relatively minor contributions to overall outcomes. When requirements are satisfied, the recommendation is to assign low priority, as investing substantial resources would yield limited benefits. However, if the requirements are not satisfied, the cIPMA approach

emphasizes that action must still be prioritized. This reflects a key principle of cIPMA: even factors of low importance must be addressed if they fall below the minimum threshold identified by NCA, as failing to meet such requirements can obstruct overall success.

Finally, the fourth quadrant, Low Importance and High Performance, includes factors that perform well but have limited strategic significance. If requirements are satisfied, management is advised to "take along," meaning performance can be maintained without additional investment. Conversely, if requirements are not satisfied, prioritizing action is still necessary to ensure these factors remain above the minimum threshold and do not negatively affect the broader system.

3.Results and Discussion

3.1 Response rate

This study used data obtained through forms distributed to respondents, specifically active consumers of the Shopee mobile commerce application. The data collection technique involved distributing questionnaires via Google Forms over a period of 100 days (December 11, 2024 – March 21, 2025) through the social media platform Instagram. Table 3 presents the response rates as follows. Table 3 shows that the author received responses from questionnaires distributed via the social media platform Instagram, totaling 238 respondents. Out of 251 respondents, 13 questionnaires were incomplete or did not meet the criteria, and therefore their data were not used in the data processing. As a result, the total response rate amounted to 238 respondents, meaning that data from all 238 respondents could be used for data processing in this study.

Table 3. Response rate of respondents

Item	Total	Percentage
Incomplete Questionnaires	13	5.18%
Complete Questionnaires	238	94.82%
Total Questionnaires	251	100%

3.2 Respondent characteristics

In this study, the sample criteria included users of the Shopee mobile commerce application who had previously made transactions on Shopee, had completed more than three transactions, and were willing to participate as respondents in this study. The sample used consisted of 238 respondents, while the minimum sample size required was 153 respondents based on calculations using G-Power 3.2. The characteristics of respondents based on gender show that out of a total of 238 respondents, females dominated with a percentage of 53.14%, while males accounted for 46.86%. This indicates slightly higher female participation in this study. Regarding age, most respondents were in the 17–25 age group, accounting for 74.48%. The 26–35 age group contributed 13.39%, followed by 36–45 years at 9.20%, and respondents over 45 years old at 2.93%. These findings indicate that the respondents were predominantly young adults.

Based on the 25 provinces of origin of the 238 respondents who completed the survey, the majority of respondents came from West Java with a percentage of 46.86%. Other regions on the island of Java, such as Central Java, DKI Jakarta, and East Java, also had a significant proportion of respondents. Meanwhile, the distribution of respondents outside Java Island is relatively small, with some provinces represented by only one respondent. Overall, the highest participation is concentrated on Java Island. In terms of the highest level of education, respondents with a D4/Bachelor's degree dominated at 46.86%, followed by high school/Vocational School graduates at 40.17%, D1/D2/D3 graduates at 10.04%, and Master's/Doctoral level at 2.93%. This shows that most respondents had a medium to high educational background. Regarding monthly income, respondents earning less than IDR 1,800,000 constituted the largest group at 41.00%. The income group of IDR 1,800,001–

2,800,000 accounted for 23.43%, followed by IDR 2,800,001–3,800,000 at 17.57%, IDR 3,800,001–4,800,000 at 10.04%, and more than IDR 4,800,000 at 7.95%. Most respondents fell into the low-income category. Finally, based on the frequency of using the Shopee application, most respondents used the app 1–3 times per month (74.48%). Users with a frequency of 4–6 times per month accounted for 20.08%, and those using it more than 6 times per month represented only 5.44%. This indicates that the intensity of app usage tends to be low to moderate.

3.3 Non-response bias analysis

The non-response bias analysis was conducted by comparing the data collection period from December 11, 2024, to March 21, 2025. Respondents who completed the questionnaire between December 11, 2024, and January 30, 2025, were categorized as early responses, totaling 77 questionnaires. Meanwhile, respondents who completed the questionnaire between January 31, 2025, and March 21, 2025, were categorized as late responses, with a total of 161 questionnaires submitted as late responses. The results of the independent t-test using IBM SPSS, as shown in Table 4, indicate that there are no significant differences between the early-response group and the late-response group across all research variables, as the significance levels are above 0.05 (2-tailed). In the description ND means not different.

Table 4. Non-response bias

Variable	Indicator	Early Response (n=77)		Late response		t-value	Sig (2-tailed)	Decision
		Mean	SD	Mean	SD			
Assurance	AS.1	4.14	0.18	4.16	0.86	-0.48	0.63	ND
	AS.2	4.23	0.74	4.18	0.82	-0.09	0.93	ND
	AS.3	3.70	1.05	3.74	1.01	-0.42	0.68	ND
	AS.4	4.78	0.60	4.72	0.69	-0.22	0.82	ND
	AS.5	4.38	0.69	4.31	0.78	0.18	0.86	ND
Information quality	IQ.1	4.26	0.71	4.20	0.81	-0.09	0.93	ND
	IQ.2	4.19	0.76	4.16	0.82	-0.35	0.73	ND
	IQ.3	4.03	0.81	3.99	0.88	-0.25	0.80	ND
	IQ.4	4.10	0.79	4.10	0.83	-0.51	0.61	ND
	IQ.5	4.05	0.84	4.06	0.90	-0.16	0.87	ND
	IQ.6	4.40	0.65	4.41	0.72	-0.32	0.75	ND
	IQ.7	4.35	0.58	4.32	0.71	-0.11	0.92	ND
Personalization	PS.1	4.31	0.59	4.27	0.71	0.00	1.00	ND
	PS.2	4.38	0.63	4.35	0.71	-0.30	0.77	ND
	PS.3	4.29	0.65	4.24	0.76	0.00	1.00	ND
Reability	RL.1	4.03	0.84	4.03	0.82	-0.55	0.59	ND
	RL.2	4.42	0.61	4.42	0.70	-0.54	0.59	ND
	RL.3	4.48	0.55	4.42	0.70	-0.11	0.91	ND
	RL.4	4.30	0.69	4.31	0.79	-0.79	0.43	ND
	RL.5	4.32	0.79	4.33	0.82	-0.26	0.80	ND
	RL.6	4.49	0.58	4.48	0.65	-0.59	0.56	ND
	RL.7	4.58	0.61	4.61	0.64	-0.65	0.52	ND
Responsiveness	RS.1	4.13	0.73	4.07	0.79	0.28	0.78	ND
	RS.2	4.09	0.81	4.06	0.82	-0.09	0.93	ND

3.4 Partial least square analysis

The normality test was used to assess whether the data follow a normal distribution by examining the skewness and kurtosis values (Sarstedt et al., 2022). Indrawati (2015) emphasizes that a normality test is required to ensure the appropriateness of the data before conducting statistical analysis. Similarly, Saputra and Marlius (2024) state that this test aims to determine whether the data are normally distributed. In this study, the

assessment was performed on the mean, standard deviation, skewness, and kurtosis values using SmartPLS 4.

Table 5. Data normality test result

Variable	Indicator	Mean	Standard Deviation	Excess Kurtosis	Skewness
Assurance	AS.1	4.155	0.838	0.465	-0.861
	AS.2	4.197	0.793	1.997	-1.081
	AS.3	3.727	1.019	-0.381	-0.485
	AS.4	4.739	0.661	14.004	-3.442
	AS.5	4.332	0.747	2.452	-1.237
Information	IQ.1	4.218	0.780	0.907	-0.833
Quality	IQ.2	4.172	0.799	-0.268	-0.570
	IQ.3	4.004	0.857	-0.594	-0.370
	IQ.4	4.101	0.814	-0.249	-0.517
	IQ.5	4.059	0.877	0.395	-0.791
	IQ.6	4.408	0.697	2.976	-1.355
	IQ.7	4.328	0.669	2.321	-1.004
Personalization	PS.1	4.282	0.674	1.644	-0.823
	PS.2	4.357	0.682	2.598	-1.152
	PS.3	4.256	0.726	1.975	-0.967
Reability	RL.1	4.029	0.822	0.719	-0.740
	RL.2	4.420	0.674	0.814	-0.993
	RL.3	4.441	0.657	2.671	-1.214
	RL.4	4.307	0.758	0.778	-0.929
	RL.5	4.328	0.806	0.472	-1.053
	RL.6	4.487	0.627	0.990	-1.035
	RL.7	4.601	0.632	4.179	-1.842
Responsiveness	RS.1	4.088	0.770	0.196	-0.542
	RS.2	4.067	0.817	-0.974	-0.311
	RS.3	4.189	0.795	1.127	-0.908
	RS.4	4.076	0.847	0.532	-0.772
	RS.5	4.017	0.917	0.426	-0.824
	RS.6	4.307	0.712	0.715	-0.877
	RS.7	4.286	0.694	0.528	-0.756
Security	SC.1	4.214	0.767	0.062	-0.725
	SC.2	4.059	0.892	-0.741	-0.510
	SC.3	4.206	0.753	-0.713	-0.480
	SC.4	3.811	1.014	-0.192	-0.539
Usability	US.1	4.265	0.740	3.653	-1.345
	US.2	4.256	0.665	0.013	-0.517
	US.3	4.139	0.723	-0.108	-0.485
	US.4	3.878	0.965	0.409	-0.827
	US.5	4.084	0.861	2.554	-1.277
	US.6	3.958	0.943	2.164	-1.308
Customer	CS.1	4.218	0.774	1.113	-0.948
Satisfaction	CS.2	4.239	0.754	3.351	-1.316
	CS.3	4.223	0.731	0.239	-0.699
	CS.4	4.298	0.654	0.614	-0.672
	CS.5	4.244	0.783	2.647	-1.252
Customer	CL.1	4.210	0.720	-0.214	-0.543
Loyalty	CL.2	4.122	0.906	0.702	-0.959
Intention	CL.3	4.160	0.926	0.689	-1.027
	CL.4	4.122	0.978	1.207	-1.197
	CL.5	4.353	0.795	1.629	-1.277

The normality analysis using SmartPLS 4.0 indicated that the mean values of all indicators were above 3.000, ranging from 3.811 to 4.601, suggesting a relatively even data distribution. The standard deviation values ranged from 0.654 to 1.019, indicating moderate variation among the indicators. Kurtosis values ranged from –0.974 to 14.004,

and skewness values ranged from –0.311 to –3.442. According to the criteria of Sarstedt et al. (2022), data from table 5 are considered normal if skewness falls between –1 and +1 and excess kurtosis is between –3 and +3. Therefore, all data in this study meet the assumption of a normal distribution.

Table 6. Outer loading score

Variable	Indicator	Outer Loading	Description
Assurance	AS.1	0.906	Valid
	AS.2	0.861	Valid
	AS.3	0.721	Valid
	AS.4	0.595	Not Valid
	AS.5	0.845	Valid
Information Quality	IQ.1	0.846	Valid
	IQ.2	0.861	Valid
	IQ.3	0.876	Valid
	IQ.4	0.885	Valid
	IQ.5	0.846	Valid
	IQ.6	0.785	Valid
	IQ.7	0.827	Valid
Personalization	PS.1	0.870	Valid
	PS.2	0.869	Valid
	PS.3	0.882	Valid
Reability	RL.1	0.589	Not Valid
	RL.2	0.869	Valid
	RL.3	0.796	Valid
	RL.4	0.824	Valid
	RL.5	0.782	Valid
	RL.6	0.812	Valid
	RL.7	0.733	Valid
Responsiveness	RS.1	0.791	Valid
	RS.2	0.818	Valid
	RS.3	0.798	Valid
	RS.4	0.801	Valid
	RS.5	0.829	Valid
	RS.6	0.712	Valid
	RS.7	0.777	Valid
Security	SC.1	0.880	Valid
	SC.2	0.897	Valid
	SC.3	0.885	Valid
	SC.4	0.595	Not Valid
Usability	US.1	0.763	Valid
	US.2	0.778	Valid
	US.3	0.754	Valid
	US.4	0.671	Not Valid
	US.5	0.834	Valid
	US.6	0.807	Valid
Customer Satisfaction	CS.1	0.875	Valid
	CS.2	0.905	Valid
	CS.3	0.888	Valid
	CS.4	0.932	Valid
	CS.5	0.826	Valid
Customer Loyalty Intention	CL.1	0.854	Valid
	CL.2	0.897	Valid
	CL.3	0.932	Valid
	CL.4	0.891	Valid
	CL.5	0.885	Valid

The outer model is used to evaluate the reliability and validity of the model, including the assessment of parameters such as Cronbach's alpha, composite reliability, convergent

validity, and discriminant validity, while also producing R^2 values as a measure of the model's predictive capability (Chasanah et al., 2021). Evaluating the outer model is necessary to understand the relationship between each block of indicators and their respective latent variables. In a reflective measurement model, the evaluation is conducted through the convergent and discriminant validity of the indicators, as well as the composite reliability of each indicator block (Ghozali & Latan, 2014). Convergent validity measures the extent to which indicators of the same construct are positively correlated and represent the same construct. The assessment of convergent validity in reflective constructs is conducted by considering the outer loadings of indicators and the Average Variance Extracted (AVE) (Sarstedt et al., 2022). An indicator is considered reliable if its correlation value exceeds 0.70, although during the scale development stage, values between 0.50 and 0.60 are still acceptable (Ghozali & Latan, 2014).

Table 6 presents the initial results of the outer loading test before the trimming process. Several indicators—namely AS.4, RL.1, SC.4, and US.4—did not meet the validity criteria, as their values were below 0.70. This indicates that the measurement model at the initial stage was not fully optimal in representing the latent constructs. Therefore, these invalid indicators were removed to improve the model quality.

The results after trimming are shown in Table 7, where all remaining indicators have outer loading values above 0.70 and are considered valid. Additionally, several indicators show increased outer loading values, suggesting that the model has become more robust and better represents the measured constructs. Thus, Table 7 reflects a measurement model that satisfies the criteria for convergent validity and is more appropriate for further analysis than Table 6.

Table 7. Outer loading score

Variable	Indicator	Outer Loading	Description
Assurance	AS.1	0.922	Valid
	AS.2	0.870	Valid
	AS.3	0.751	Valid
	AS.5	0.834	Valid
Information Quality	IQ.1	0.846	Valid
	IQ.2	0.861	Valid
	IQ.3	0.876	Valid
	IQ.4	0.885	Valid
	IQ.5	0.846	Valid
	IQ.6	0.785	Valid
	IQ.7	0.827	Valid
Personalization	PS.1	0.870	Valid
	PS.2	0.869	Valid
	PS.3	0.882	Valid
Reability	RL.2	0.874	Valid
	RL.3	0.793	Valid
	RL.4	0.844	Valid
	RL.5	0.794	Valid
	RL.6	0.824	Valid
	RL.7	0.739	Valid
Responsiveness	RS.1	0.791	Valid
	RS.2	0.818	Valid
	RS.3	0.798	Valid
	RS.4	0.801	Valid
	RS.5	0.829	Valid
	RS.6	0.712	Valid
	RS.7	0.777	Valid
Security	SC.1	0.923	Valid
	SC.2	0.911	Valid
	SC.3	0.889	Valid
Usability	US.1	0.757	Valid
	US.2	0.792	Valid

	US.3	0.778	Valid
	US.5	0.835	Valid
	US.6	0.811	Valid
Customer Satisfaction	CS.1	0.875	Valid
	CS.2	0.906	Valid
	CS.3	0.888	Valid
	CS.4	0.933	Valid
	CS.5	0.825	Valid
Customer Loyalty Intention	CL.1	0.854	Valid
	CL.2	0.897	Valid
	CL.3	0.932	Valid
	CL.4	0.891	Valid
	CL.5	0.885	Valid

The outer loading analysis revealed four invalid indicators, namely AS.4, RL.1, SC.4, and US.4, with outer loading values below 0.70. According to Ghozali & Latan (2014), in the evaluation of reflective measurement models, outer loading values must exceed 0.70 for an indicator to be considered valid. Therefore, indicators with values below 0.70 were removed or trimmed to ensure that the measurement model meets the validity criteria. The analysis results indicate that all variable items have loading factor or outer loading values ranging from 0.712 to 0.933, thereby meeting the minimum requirement of 0.70 and being considered valid (Siregar et al., 2022). This convergent validity not only ensures measurement accuracy but also supports strategies for improving Shopee's service quality, which can foster customer loyalty through satisfaction as a key mediator. Furthermore, the Average Variance Extracted (AVE) was calculated for each construct. A model is considered good if the AVE value of each construct exceeds 0.50, as this indicates that the construct can explain more than half of the variance of its indicators (Ghozali & Latan, 2014; Sarstedt et al., 2022). The AVE calculation results in Table show that all constructs meet this criterion, confirming the convergent validity of the model.

The Average Variance Extracted (AVE) in Table 8 values for all variables are above 0.50. The assurance variable has an AVE value of 0.716; information quality is 0.718; personalization is 0.764; reliability is 0.660; responsiveness is 0.624; security is 0.824; usability is 0.632; customer satisfaction is 0.785; and customer loyalty intention is 0.796. These results indicate that each variable is able to explain more than half of the variance of its indicators, confirming that all constructs meet the criteria for convergent validity.

Table 8. Averange variance extended (AVE) score result

Variable	Average Variance Extended (AVE)
Assurance	0.716
Information Quality	0.718
Personalization	0.764
Reability	0.660
Responsiveness	0.624
Security	0.824
Usability	0.632
Customer Satisfaction	0.785
Customer Loyalty Intention	0.796

Discriminant validity in the reflective model is assessed through cross-loadings, by comparing the correlation between each indicator and its corresponding construct with the indicator's correlation with other constructs. The model is considered valid when an indicator shows a higher correlation with its own construct than with any other construct, indicating that the latent construct predicts the indicators within its block more accurately (Ghozali & Latan, 2014). Based on the SmartPLS analysis, all indicators meet this criterion, confirming that the model satisfies discriminant validity.

Table 9. Cross loading

	AS.	CL.	CS.	IQ.	PS.	RL.	RS.	SC.	US.
AS.1	0.922	0.640	0.679	0.674	0.636	0.685	0.627	0.667	0.676
AS.2	0.870	0.529	0.567	0.604	0.522	0.557	0.512	0.535	0.560
AS.3	0.751	0.554	0.538	0.567	0.454	0.491	0.593	0.607	0.625
AS.5	0.834	0.618	0.639	0.649	0.648	0.710	0.628	0.590	0.625
CL.1	0.682	0.854	0.820	0.690	0.728	0.723	0.705	0.682	0.737
CL.2	0.603	0.897	0.718	0.569	0.557	0.599	0.600	0.644	0.640
CL.3	0.580	0.932	0.762	0.595	0.533	0.570	0.534	0.552	0.615
CL.4	0.611	0.891	0.766	0.567	0.518	0.524	0.514	0.524	0.716
CL.5	0.613	0.885	0.746	0.644	0.600	0.660	0.473	0.496	0.622
CS.1	0.654	0.775	0.875	0.652	0.654	0.668	0.608	0.585	0.680
CS.2	0.623	0.734	0.906	0.685	0.664	0.685	0.631	0.586	0.708
CS.3	0.659	0.721	0.888	0.669	0.711	0.620	0.713	0.669	0.686
CS.4	0.637	0.806	0.933	0.754	0.757	0.757	0.700	0.678	0.717
CS.5	0.617	0.758	0.825	0.610	0.586	0.604	0.554	0.561	0.747
IQ.1	0.627	0.651	0.626	0.846	0.613	0.588	0.634	0.631	0.552
IQ.2	0.629	0.637	0.631	0.861	0.597	0.600	0.600	0.646	0.570
IQ.3	0.606	0.605	0.599	0.876	0.635	0.592	0.690	0.667	0.571
IQ.4	0.621	0.567	0.632	0.885	0.688	0.612	0.675	0.575	0.553
IQ.5	0.622	0.546	0.704	0.846	0.680	0.625	0.694	0.564	0.642
IQ.6	0.629	0.562	0.662	0.785	0.709	0.732	0.597	0.516	0.631
IQ.7	0.642	0.523	0.648	0.827	0.680	0.738	0.657	0.587	0.648
PS.1	0.654	0.560	0.596	0.700	0.870	0.655	0.659	0.569	0.587
PS.2	0.583	0.604	0.708	0.660	0.869	0.706	0.639	0.539	0.651
PS.3	0.539	0.567	0.684	0.683	0.882	0.604	0.687	0.629	0.599
RL.2	0.652	0.550	0.641	0.641	0.612	0.874	0.616	0.526	0.634
RL.3	0.573	0.481	0.593	0.649	0.635	0.793	0.630	0.530	0.585
RL.4	0.624	0.614	0.628	0.654	0.675	0.844	0.600	0.620	0.645
RL.5	0.594	0.586	0.590	0.539	0.558	0.794	0.638	0.617	0.614
RL.6	0.514	0.532	0.580	0.585	0.559	0.824	0.536	0.451	0.503
RL.7	0.584	0.601	0.636	0.623	0.609	0.739	0.547	0.468	0.603
RS.1	0.571	0.542	0.631	0.635	0.613	0.611	0.791	0.630	0.611
RS.2	0.554	0.513	0.573	0.593	0.545	0.619	0.818	0.676	0.599
RS.3	0.592	0.478	0.520	0.567	0.546	0.564	0.798	0.648	0.566
RS.4	0.550	0.459	0.542	0.573	0.553	0.489	0.801	0.610	0.574
RS.5	0.475	0.458	0.514	0.612	0.597	0.502	0.829	0.660	0.597
RS.6	0.567	0.643	0.623	0.630	0.693	0.616	0.712	0.678	0.576
RS.7	0.535	0.391	0.568	0.615	0.608	0.618	0.777	0.629	0.565
SC.1	0.636	0.574	0.637	0.688	0.595	0.612	0.780	0.923	0.633
SC.2	0.595	0.633	0.625	0.601	0.602	0.548	0.744	0.911	0.618
SC.3	0.701	0.568	0.633	0.630	0.607	0.635	0.714	0.889	0.718
US.1	0.631	0.551	0.595	0.550	0.610	0.620	0.614	0.647	0.757
US.2	0.643	0.604	0.612	0.701	0.699	0.711	0.726	0.674	0.792
US.3	0.621	0.569	0.579	0.557	0.578	0.649	0.626	0.579	0.778
US.5	0.515	0.599	0.723	0.547	0.498	0.536	0.505	0.487	0.835
US.6	0.538	0.655	0.651	0.464	0.434	0.445	0.508	0.517	0.811

The cross-loading analysis in table 8 shows that each indicator has a higher correlation with its own construct than with any other construct. This finding confirms that all constructs meet discriminant validity, as indicated by indicator correlation values consistently exceeding 0.70 (Ramayah et al., 2018). This validity further strengthens the reliability of the research instrument in accurately representing each construct, particularly those related to service quality, customer satisfaction, and loyalty intention on the Shopee platform. The results of the discriminant validity test using the Fornell–Larcker Criterion are presented in the following section.

Table 10. Fornell-larcker criterion

	AS	CL	CS	IQ	PS	RL	RS	SC	US
AS	0.846								
CL	0.694	0.892							
CS	0.720	0.857	0.886						
IQ	0.739	0.689	0.762	0.847					
PS	0.674	0.662	0.763	0.778	0.874				
RL	0.729	0.692	0.755	0.759	0.750	0.812			
RS	0.699	0.637	0.725	0.768	0.757	0.733	0.790		
SC	0.710	0.652	0.696	0.705	0.662	0.660	0.822	0.908	
US	0.735	0.749	0.799	0.706	0.702	0.738	0.742	0.724	0.795

The Fornell–Larcker results in Table 10 indicate that each construct demonstrates strong discriminant validity, as shown by the square root of the AVE values being greater than the correlations with other constructs. This finding confirms that the dimensions of service quality are truly distinct and that no overlap occurs among the constructs. Therefore, the research model not only meets the discriminant validity criteria but is also ready to proceed to the structural analysis stage, particularly in examining the influence of service quality on loyalty intention through customer satisfaction on the Shopee platform. Composite reliability is used in PLS to assess the internal consistency of the measurement instrument. A construct is considered reliable if it has a composite reliability value above 0.70 (Ghozali, 2021). Table 11 presents the results of the composite reliability calculations obtained from the analysis using SmartPLS.

Table 11. Composite reliability result

Variable	Composite Reliability
Assurance	0.876
Information Quality	0.935
Personalization	0.850
Reability	0.897
Responsiveness	0.900
Security	0.893
Usability	0.859
Customer Satisfaction	0.932
Customer Loyalty Intention	0.937

The analysis results indicate that the composite reliability values for all variables exceed 0.70, signifying that all variables meet the established reliability criteria. In addition, Cronbach's alpha is also used to assess the internal consistency of the instrument. According to Sarstedt al. (2022), Cronbach's alpha is a reliability measure that assumes equal indicator loadings, with an ideal value greater than 0.60. Table 12 presents the results of the Cronbach's alpha calculations.

Table 12. Cronbach's alpha result

Variable	Cronbach's Alpha
Assurance	0.866
Information Quality	0.934
Personalization	0.846
Reability	0.896
Responsiveness	0.899
Security	0.893
Usability	0.855
Customer Satisfaction	0.931
Customer Loyalty Intention	0.936

The Cronbach's alpha analysis results show that all variables have values above 0.60, indicating that the instrument is reliable and meets the established criteria. Meeting the

criteria for both composite reliability and Cronbach's alpha not only ensures the reliability of the instrument but also strengthens the research findings that improvements in Shopee's service quality have a significant impact on customer satisfaction and loyalty, as measured through consistent and trustworthy indicators.

After confirming that the outer model meets the required criteria, the next step is to evaluate the inner model, or structural model. The inner model evaluation aims to assess the influence of independent variables on dependent variables in this study. This analysis uses path values to examine the relationships between variables and determine the strength of each variable's effect within the model. The inner model results provide the basis for hypothesis testing and understanding the cause-and-effect relationships among the research constructs is mention on Figure 3.

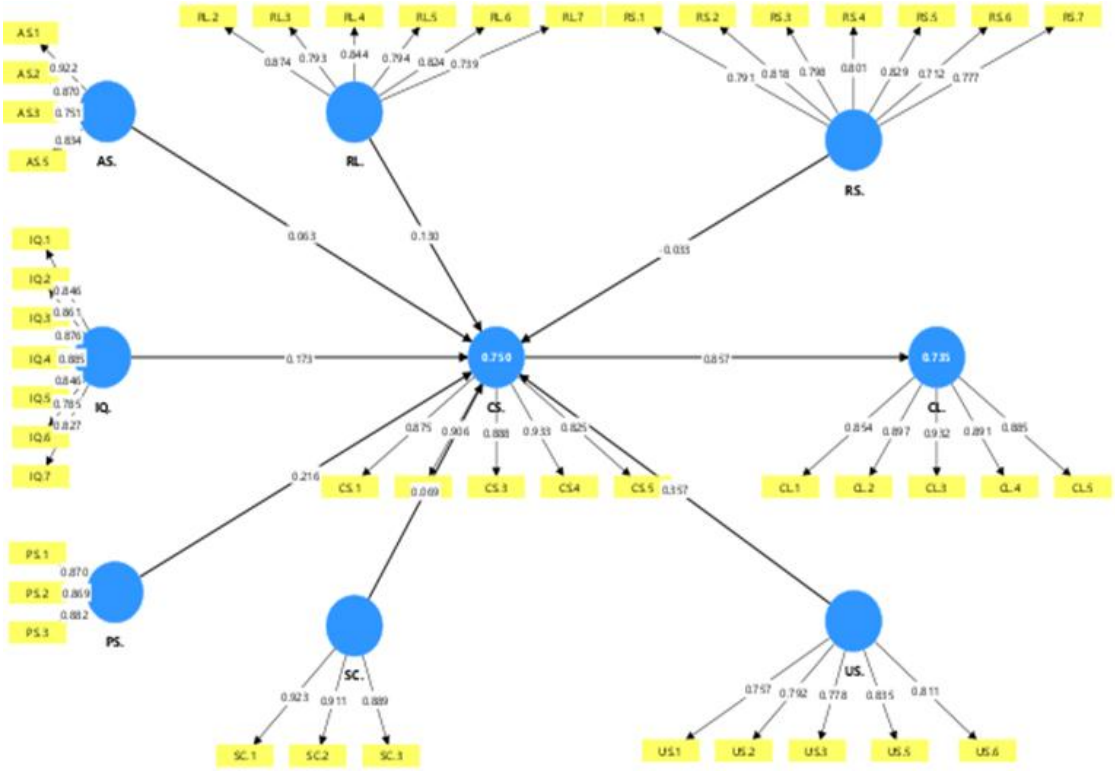

Fig. 3. Inner model

The initial stage in evaluating the inner model is the multicollinearity test, which assesses the extent of collinearity among indicators in a formative measurement model. This assessment is conducted using the Variance Inflation Factor (VIF), which is directly related to the tolerance value. Ideally, VIF values should be below 3 and not exceed 5 to avoid significant collinearity issues (Sarstedt et al., 2022). This test ensures that the indicators in the model can be used independently without high redundancy the result of our research is mention on Table 13.

Table 13. Collinerarity statistics (VIF)

Construct		VIF
Customer Satisfaction	Assurance	3.079
	Information Quality	3.758
	Personalization	3.336
	Reability	3.384
	Responsiveness	4.564
	Security	3.605
	Usability	3.192
Customer Loyalty Itention	Customer Satisfaction	1.000

Based on the collinearity statistics, all variables show VIF values below the critical threshold of 5, although some exceed the ideal value of 3, indicating correlations among variables within the customer satisfaction construct. The VIF values are as follows: assurance 3.079, information quality 3.758, personalization 3.336, reliability 3.384, responsiveness 4.564, security 3.605, and usability 3.192, reflecting correlations among each variable with the others in the customer satisfaction construct. Meanwhile, the customer satisfaction variable has a VIF of 1.000, indicating a reasonable correlation with the customer loyalty intention variable. These results suggest that there are no significant multicollinearity issues in the model.

The coefficient of determination (R^2) measures the extent to which the variation in an endogenous construct is explained by its associated exogenous constructs (Sarstedt et al., 2022). The result of research is mention on Table 13, the results indicate that customer loyalty intention is influenced by the variables assurance, information quality, personalization, reliability, responsiveness, security, and usability, with an R^2 value of 0.735 or 73.5%, while the remaining 27.5% is affected by other factors. Meanwhile, customer satisfaction is influenced by the same variables with an R^2 value of 0.750 or 75.0%, leaving 25.0% of the variation explained by other factors. These high R^2 values suggest that the predictive model is quite robust, validating the theoretical model and providing an empirical basis for Shopee management to optimize service quality across the identified dimensions.

Table 14. Coefficient of determination

Variable	R Square
Customer Loyalty Intention	0.735
Customer Satisfaction	0.750

Predictive relevance (Q^2) is used to evaluate the predictive capability of the structural model, where a Q^2 value greater than 0 indicates that the model has good predictive relevance (Duryadi, 2021; Ghozali, 2021). The table 15 shows that the customer satisfaction variable has a Q^2 value of 0,614, while customer loyalty intention has a Q^2 value of 0,728. Both values are well above 0, indicating that the model has large predictive relevance. These findings demonstrate that the dimensions of service quality—including assurance, information quality, personalization, reliability, responsiveness, security, and usability—are significantly capable of predicting Shopee customers' satisfaction and loyalty.

Table 15. Predictive relevance

Variable	Q-Square	Description
Customer Satisfaction	0.614	Well-Conducted Observation
Customer Loyalty Intention	0.728	Well-Conducted Observation

The f-square value is used to determine the extent to which exogenous variables influence endogenous variables within the structural model (Ramadhan et al., 2024). According to Ghozali & Latan (2014), f^2 values of 0.02, 0.15, and 0.35 indicate small, medium, and large effects, respectively. The Table 15 shows that usability has the largest effect size, with a value of 0.159, placing it in the large effect category. Personalization falls into the medium category with a value of 0.056, while responsiveness exhibits a very small effect with a value of 0.001. Reliability demonstrates a medium effect with a value of 0.020, whereas security shows a small effect with a value of 0.005. Additionally, assurance has an f-square value of 0.005 and information quality has a value of 0.032, both indicating small effects within the model.

Table 16. Effect size

Variable	F Square
Assurance	0.005
Information Quality	0.032
Personalization	0.056
Reability	0.020
Responsiveness	0.001
Security	0.005
Usability	0.159

Hypothesis testing in this study was conducted to assess the relationships among variables within the structural model (Sarstedt et al., 2022). Following Zariman et al. (2022), the testing procedure was carried out using bootstrapping by evaluating the significance of the hypothesized relationships based on the t-statistic and p-value. With a significance level of 0.05, a coefficient is considered significant if the t-value exceeds 1.645 for a one-tailed test or 1.974 for a two-tailed test, and if the p-value is below 0.05 (Sarstedt et al., 2022). The bootstrapping results are then used to determine whether each research hypothesis is accepted or rejected.

The path coefficient analysis shows that the variables information quality, personalization, reliability, responsiveness, and customer satisfaction have a significant positive effect, based on the criteria of p-value < 0.05 and t-statistic ≥ 1.645. For example, the information quality variable has a p-value of 0.000 and a t-statistic of 41.561, indicating a significant positive influence on customer satisfaction. Meanwhile, the variables assurance, security, and usability do not show a significant effect or even have a negative influence on customer satisfaction. These results were obtained from the non-directional bootstrapping path coefficient analysis.

Table 17. Path coefficient bootstrapping (Directional)

Hypothesis	Path	Original Sample	T Statistic (≥1.645)	P Value	Description
H1	AS -> CS	0.063	0.835	0.404	Rejected
H2	IQ -> CS	0.857	41.561	0.000	Accepted
H3	PS -> CS	0.173	2.608	0.009	Accepted
H4	RL -> CS	0.216	2.590	0.010	Accepted
H5	RS -> CS	0.130	2.010	0.044	Accepted
H6	SC -> CS	-0.033	0.413	0.680	Rejected
H7	US -> CS	0.069	1.084	0.278	Rejected
H8	CS -> CL	0.357	5.447	0.000	Accepted

The non-directional path coefficient results indicate that the variables information quality, personalization, reliability, and responsiveness have a significant positive effect on customer satisfaction, which mediates customer loyalty intention, based on the criteria of p-value < 0.05 and t-statistic ≥ 1.974. In contrast, the variables assurance, security, and usability do not show a significant effect or even exhibit a negative influence on customer satisfaction mediating customer loyalty intention.

Table 18. Path coefficient bootstrapping (Non-Directional)

Hypothesis	Path	Original Sample	T Statistic (≥1.974)	P Value	Description
H9	AS -> CS -> CL	0.054	0.836	0.403	Rejected
H10	IQ -> CS -> CL	0.149	2.585	0.010	Accepted
H11	PS -> CS -> CL	0.186	2.569	0.010	Accepted
H12	RL -> CS -> CL	0.112	1.994	0.046	Accepted
H13	RS -> CS -> CL	-0.028	0.411	0.681	Rejected
H14	SC -> CS -> CL	0.059	1.079	0.281	Rejected
H15	US -> CS -> CL	0.306	5.430	0.000	Accepted

3.5 Discussion

Based on the data processed from 238 respondents using Structural Equation Modeling (SEM) with SmartPLS 4.1.1.1, this study analyzed user responses to nine key variables: assurance, information quality, reliability, responsiveness, security, usability, customer satisfaction, and customer loyalty intention. The purpose of the study was to examine the influence of these variables on customer loyalty intention through customer satisfaction among Shopee m-commerce users.

The demographic results indicate that the majority of respondents were female, totaling 127 individuals (53.14%), with the largest age group being 17–25 years old, consisting of 178 respondents (74.48%). Most respondents were from West Java, numbering 112 (46.86%), and used the Shopee app 1–3 times per month, totaling 177 respondents (74.48%). Additionally, the majority of respondents had a monthly income of less than IDR 1,800,000, comprising 97 individuals (41.00%). These data provide an overview of the main characteristics of Shopee m-commerce users who served as the study's sample.

The respondents' feedback on the studied variables was interpreted using the mean scores of the answers based on the measurement scale by Sekaran & Bougie (2016). The assurance variable received a mean score of 4.27, indicating high user trust in Shopee's guarantees, with indicators such as "Shopee is widely recognized" achieving 81.51% of respondents strongly agreeing. Information quality scored an average of 4.15, showing that users perceive the information provided by Shopee as relevant, timely, and easy to understand. The personalization variable averaged 4.20, reflecting Shopee's ability to tailor services to user preferences, although some users felt their needs were not fully understood. Reliability scored 4.17, highlighting that users consider Shopee consistent and dependable, particularly in order delivery and confirmation processes. Responsiveness had an average of 4.27, indicating that Shopee effectively addresses user issues and provides relevant responses, while security achieved the highest mean of 4.35, showing strong user confidence in the protection of personal and payment information. Usability averaged 4.12, suggesting the app is user-friendly with organized structure and consistent navigation, though improvements are possible. Customer satisfaction scored 4.38, reflecting a very high level of satisfaction with Shopee's services, product offerings, and overall shopping experience. Finally, customer loyalty received a mean score of 4.33, demonstrating strong user intention to continue using Shopee, supported by high satisfaction and preference over other platforms. These findings collectively indicate that Shopee effectively meets user expectations across multiple service quality dimensions, which contribute to customer satisfaction and loyalty.

3.5.1 Hypothesis discussion

Based on data analysis from 238 respondents using SmartPLS 4, the study examined the influence of various service quality dimensions on customer satisfaction and loyalty intention in Shopee's mobile commerce application. H1 results indicated that assurance does not significantly affect customer satisfaction (original sample = 0.063; t-statistic = 0.835; p-value = 0.404), which contradicts Zariman et al. (2022) but aligns with Suryawirawan et al. (2022) and Ilieva et al. (2022), suggesting other factors like system reliability and responsiveness may be more influential. H2 showed information quality has a positive and significant effect on customer satisfaction (original sample = 0.173; t = 2.608; p = 0.009), consistent with Zariman et al. (2022), Kim et al. (2021), and Amarin & Wijaksana (2021). Similarly, H3 indicated personalization positively impacts customer satisfaction (original sample = 0.216; t = 2.590; p = 0.010), in line with Zariman et al. (2022), Wisnel et al. (2022), and Nandankar et al. (2021), emphasizing perceived attention and relevance in digital services. H4 confirmed reliability positively affects customer satisfaction (original sample = 0.130; t = 2.010; p = 0.044), supporting Hilwa & Latief (2022) and Saraswati et al. (2023), although differing from Zariman et al. (2022). H5 and H6 revealed that

responsiveness (original sample = -0.032; t = 0.413; p = 0.680) and security (original sample = 0.069; t = 1.084; p = 0.278) do not significantly influence customer satisfaction, These findings are in line with the research by Darmayunata & Mildawati (2022), who argue that responsiveness has no effect on customer satisfaction because customer expectations regarding service speed will continue to change in line with upward trends over time. Zariman et al. (2022) stated that there is no positive and significant effect between security and customer satisfaction. Cristobal et al. (2007) explained in Rama & Barusman, (2019) that this is because consumers consider security to be a basic requirement in online shopping. Its absence causes dissatisfaction, but its presence does not always increase satisfaction. H7 demonstrated that usability significantly enhances customer satisfaction (original sample = 0.357; t = 5.447; p = 0.000), consistent with Hasan et al. (2022) and Nurhanifa et al. (2022), highlighting the importance of user-friendly layout and navigation.

For the effect on customer loyalty intention, H8 confirmed that customer satisfaction strongly influences loyalty (original sample = 0.857; t = 41.561; p = 0.000), aligning with Zariman et al. (2022), Candiwan & Wibisono (2021), and Wisnel et al. (2022). Mediation analysis revealed that H9 (assurance) did not significantly mediate loyalty via customer satisfaction The results of this study are in line with Tarkang et al., (2023) and Abdullah et al., (2022) which further explain that if an application fails to provide a consistent or responsive experience, customer trust will decline, so that assurance is not strong enough to directly influence loyalty. H10 (information quality) has significantly mediate loyalty via customer satisfaction, whereas H11 (personalization), H12 (reliability), and H15 (usability) showed positive and significant mediation effects, supporting previous studies (Zariman et al., 2022; Wisnel et al., 2022; Hariyanto & Rachmawati, 2022; Hong & Hai, 2018). Conversely, H13 (responsiveness) and H14 (security) did not show significant mediation effects, consistent with prior findings (Zariman et al., 2022; Palladan & Ahmad, 2019; Anderson & Srinivasan, 2003; Rama & Barusman, 2019).

Overall, the findings suggest that in the context of mobile commerce applications like Shopee, users prioritize information accessibility, personalized services, system reliability, and usability over assurance, responsiveness, and security. These results partially align with Heizer's (2020) operations management theory emphasizing service performance for customer satisfaction but indicate that the modified SERVQUAL model (Zariman et al., 2022) may not fully capture the determinants of satisfaction and loyalty in this context.

3.5.2 Combined importance-performance map analysis (cIPMA) discussion

The cIPMA (combined Importance-Performance Map Analysis) method was developed by Hauff et al. (2024) in response to the limitations of traditional IPMA (Importance-Performance Map Analysis) in PLS-SEM. cIPMA is an extension of Importance Performance Map (IPMA) analysis in PLS-SEM that integrates Necessary Condition Analysis (NCA) results to provide a more comprehensive perspective in evaluating the determining factors of a target construct (Hauff et al., 2024). This study uses SmartPLS 4 to identify the results of the Importance-Performance Matrix Analysis (IPMA) and then integrates the results of the Necessary Condition Analysis (NCA) to become cIPMA (Combined Importance-Performance Map Analysis). Table 19 below shows the results of the combined importance performance.

Table 19. CE-FDH bottleneck table (actual values)

	LV scores								
	CL	AS	CS	IQ	PS	RL	RS	SC	US
0.000%	13.719	NN	NN	NN	NN	NN	NN	NN	NN
10000%	22.347	35.284	25.226	35.924	40.937	18.088	25.374	11.822	25.229
20000%	30.975	35.284	25.226	35.924	40.937	18.088	25.374	11.822	25.229
30000%	39.603	35.284	37.756	50.827	48.650	49.572	42.568	11.822	42.444
40000%	48.231	35.284	37.756	54.103	59.063	54.650	42.568	11.822	42.444
50000%	56.859	35.284	37.756	54.103	59.063	55.160	42.568	11.822	42.444
60000%	65.487	35.284	58.347	54.103	59.063	55.160	42.568	11.822	42.444
70000%	74.116	35.284	71.373	54.103	66.776	55.160	51.923	33.333	42.444

80000%	82.744	68.745	71.373	54.103	66.776	69.365	60.296	33.333	53.061
90000%	91.372	69.250	71.373	54.103	75.000	69.365	60.296	33.333	53.061
100000%	100.000	69.250	71.373	54.103	75.838	72.113	68.986	33.333	71.463

In addition to traditional hypothesis testing based on regression using sufficiency logic, this study uses necessary condition analysis to test the proposed effects based on necessity logic (Dul et al., 2020), as shown in Figure 4.

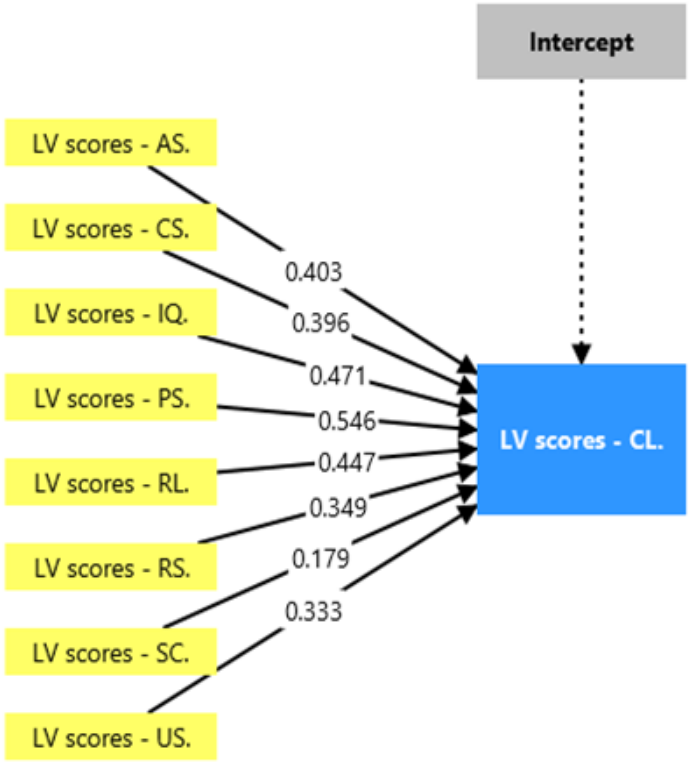

Fig. 4. NCA results

Based on the results presented in Table 20, the importance, performance, and Necessary Condition Analysis (NCA) values for each construct reveal differentiated contributions to the outcome variable. The assurance dimension demonstrates a relatively low importance value (0.063), with a performance score of 78.499 and an NCA value of 69.250, indicating that while assurance performs well, its role as a critical driver remains limited. Information quality exhibits a moderate level of importance (0.173) accompanied by a high performance score of 79.943. However, its NCA value of 54.103 suggests that this construct does not function as a strict necessary condition for achieving the desired outcome. Similarly, personalization shows a comparatively higher importance value (0.216) and strong performance (82.516), with an NCA score of 75.000, indicating that personalization plays a more substantial role both in terms of influence and necessity. Reliability records an importance value of 0.130 and a high performance score of 82.986, while its NCA value reaches 69.365, suggesting that reliability contributes meaningfully to performance outcomes but is not the most critical constraining factor. In contrast, responsiveness exhibits a negative importance value (-0.033), despite a relatively high performance score of 75.927 and an NCA value of 60.296.

This result implies that improvements in responsiveness may not significantly enhance the outcome variable and could even be marginally redundant when other constructs are present. The security construct displays a low importance value (0.069), combined with a performance score of 72.179 and a relatively low NCA value of 33.333, indicating that security, although necessary at a baseline level, is less decisive in determining the achievement of the desired outcome. Finally, usability emerges as the most influential construct, with the highest importance value (0.357), a solid performance score of 75.883,

and an NCA value of 53.061. This finding highlights usability as a key driver, suggesting that improvements in this area are more likely to yield meaningful gains.

Table 20. NCA results

Construct	CE-FDH effect size	95.0%	p-value	Importance	Performance	Remark
Assurance→ CL	0.403	0.200	0.000	0.063	78.499	Necessary
Customer Satisfaction→ CL	0.396	0.104	0.000	0.857	78.510	Necessary
Information Quality→ CL	0.471	0.241	0.000	0.173	79.943	Necessary
Personalization→ CL	0.546	0.247	0.000	0.216	82.516	Necessary
Reability→ CL	0.447	0.161	0.000	0.130	82.986	Necessary
Responsiveness→ CL	0.349	0.120	0.000	-0.033	75.927	Necessary
Security→ CL	0.179	0.085	0.000	0.069	72.179	Necessary
Usability→ CL	0.333	0.119	0.000	0.357	75.883	Necessary

From Table 20 and Figure 5, to achieve a consumer loyalty intensity level of 90% (scale of 0–100%), it must have a minimum score of 69.250 for assurance, 54.103 for information quality, 75.000 for personalization, and 69.365 for reliability. A score of 60.296 for responsiveness, a score of 33.333 for security, a score of 53.061 for usability. Finally, a customer satisfaction score of 71.373. Assuming that the responses indicate that the seven service quality variables influence consumer loyalty through customer satisfaction at values below the specified threshold, the desired consumer loyalty will not be achieved.

In the previous discussion in table 16 and 17, PLS-SEM identified that information quality, personalisation, reliability, and usability have a significant effect on customer satisfaction, which in turn drives customer loyalty. Conversely, assurance, responsiveness, and security do not show a significant linear effect, indicating that these variables do not function as drivers. However, the NCA results in Table 19 confirm that all dimensions of service quality are necessary conditions for the formation of customer loyalty because the p values are < 0.05 and the effect size d is > 0.10 (Hauff et al., 2024), so that minimum performance on each variable must still be met. In Graph 1, all constructs are necessary, marked in white to distinguish whether the construct is a necessary condition (marked in white) or not necessary (marked in black/shaded).

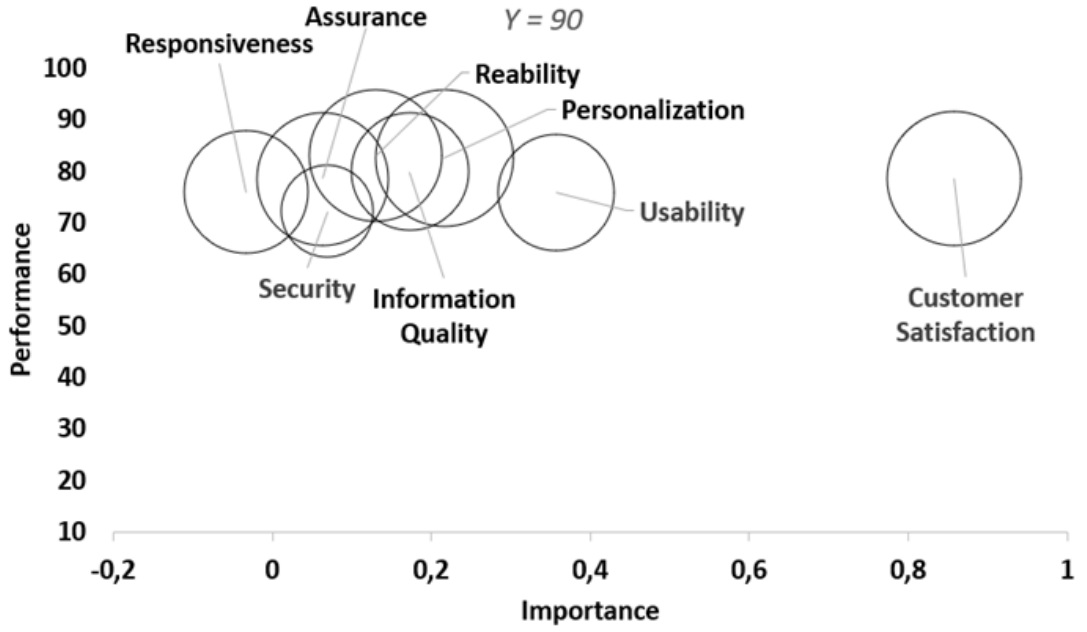

Fig. 5. cIPMA

The insignificant effect of assurance, responsiveness, and security on customer satisfaction can be explained through the hygiene factors perspective derived from Herzberg's Two-Factor Theory, in which these variables are considered basic standards that are expected by e-commerce platform users, elements that do not always increase satisfaction when present, but can cause significant dissatisfaction when absent. In the context of service provision, these factors are crucial for maintaining a basic level of customer satisfaction (Sewchurran & Brown, 2011).When aspects of security, response reliability, and service assurance are at an adequate level, further improvements no longer result in significant additional satisfaction, but their failure can cause serious dissatisfaction. This opinion is in line with the NCA results, which classify all variables as necessary conditions.

Based on the results of the cIPMA analysis as a managerial recommendation, the customer satisfaction variable is in the High Importance and High Performance quadrant, indicating that this variable is a key factor and has been well managed by the company. If the requirement is satisfied (Is Satisfied), then the managerial recommendation is to maintain existing performance by ensuring the sustainability of effective practices. However, if the requirements are not met (Is Not Satisfied), management needs to prioritise corrective actions even though performance is relatively high, as this variable has the potential to hinder the achievement of higher performance targets.

Meanwhile, the variables of assurance, information quality, personalisation, reliability, responsiveness, security, and usability are in the Low Importance and High Performance quadrant, indicating that the performance of these variables is already good even though their level of importance is relatively low. If the requirements are satisfied (Is Satisfied), the managerial recommendation is to maintain current performance without the need for significant additional investment. Conversely, if the requirements are not met (Is Not Satisfied), management needs to prioritise actions to ensure that performance remains above the minimum threshold, so as not to hinder the overall performance of the system.

The results of this study show similarities and differences with the findings of Zariman et al. (2022) on service quality in mobile commerce applications. The similarities lie in the variables of information quality and personalisation, which were found to have a significant effect, and the variable of security, which had no effect on customer satisfaction and customer loyalty. As for the differences, Zariman et al.'s (2022) study found that reliability and usability had a significant negative effect, whereas in this study, these two variables had a positive effect. In addition, assurance and responsiveness in this study show a negative effect, while in the study by Zariman et al. (2022), both have a positive effect. Furthermore, this study uses the cIPMA (combined importance-performance matrix analysis) approach from Hauff et al. (2024) to identify service indicators that are considered important through the perspective of necessary condition analysis (NCA).

4. Conclusions

Based on the findings from Shopee m-commerce users, Information Quality, Personalization, Reability and Usability were found to have a positive and significant effect on customer satisfaction, whereas Assurance, Responsiveness, and Security did not show significant influence. Furthermore, customer satisfaction plays a significant mediating role in enhancing customer loyalty intention, particularly through Information Quality, Personalization, Reliability, and Usability. The findings indicate that while not all service quality dimensions linearly enhance customer loyalty through satisfaction, all of them remain necessary conditions that must be fulfilled. This confirms that customer loyalty in e-commerce is driven by both sufficiency and necessity logic, rather than linear effects alone.

This study also highlights limitations, including its focus on a single m-commerce platform (Shopee) and the use of purposive sampling, which may introduce bias. For managerial practice, it is recommended that Shopee improve underperforming dimensions while maintaining performance in strong areas. Future research is suggested to explore other m-commerce platforms or social commerce, incorporate supporting variables such as

Fulfillment and Efficiency, and broaden the industry scope to identify emerging trends in customer satisfaction and loyalty.

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We encourage all authors of articles published in this journal to share their research data. This section provides details regarding where data supporting reported results can be found, including links to publicly archived datasets analyzed or generated during the study. A statement is still required when no new data is created or unavailable due to privacy or ethical restrictions.

Conflicts of Interest
The authors declare no conflict of interest.

Declaration of Generative AI Use
During the preparation of this work, the author(s) used Grammarly to assist in improving grammar, clarity, and academic tone of the manuscript. After using this tool, the author(s) reviewed and edited the content as needed and took full responsibility for the content of the publication.

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